



Back to Basics: A Framework for Leather Manufacture

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Reciprocating multi-roller machines: The shaving machine in operation

The operation normally follows splitting and shaves the flesh side of the leather reducing its substance. Many variables make shaving a complex process, which needs careful examination to properly assess its effect.

Only the classic reciprocating multi-roller machine is in current use. Attempts to develop a practical throughfeed shaver have not been successful at the time of this publication.

KEY OBJECTIVES:

Primary objective:

To reduce substance.

Secondary objective:

To produce stretching and setting.

The moisture content of the leather is a critical factor determining the quality of the shaved surface. Normally, the aim is to commence shaving with a minimum of 50% moisture content, although this may vary according to the softness and stretch of the piece. The temperature of the leather undergoing shaving may further influence the characteristics of the shaved leather. It is noted that “dry” shaving is also practised to produce a higher degree of accuracy on staked and finish dried leather.

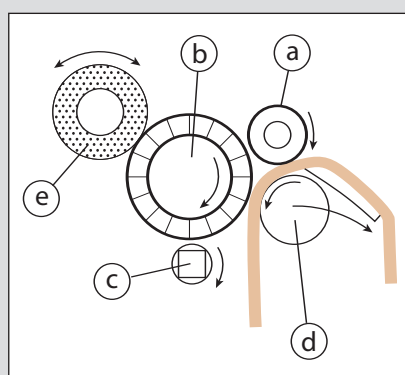
Because the spiral knife cylinder is the tool employed, a degree of setting and alignment of the fibre structure of the leather takes place. For this reason the substance of the leather is uniform immediately after shaving, despite the variations in the character of the fibre structure of the different parts of the leather.

The mechanism of shaving

The shaving machine is a true reciprocating multi-roller tool. However, it differs from the rest of the family as the process is performed on in-feed system

machines. This can be likened to an operation known in engineering as climb milling. (*Note: outfeed systems at one time were widespread with small animal skins shaving*).

Panel E14/1: Shaving in the in-feed mode



a. Transport Roller b. Spiral Cylinder c. Deflection Roller d. Feed Roller e. Knife Grinder

In in-feed construction, shown as *Panel E14/1*, the main static frame carries the transport roller (a) and the spiral knife cylinder (b), (*sometimes adjustable for position to set substance*). A rotor or deflection roller (c) is also fitted, with the function of avoiding entanglement or wrap-around of the leather. The feed roller, also functioning as the support roller, (d) is part of the reciprocating frame. Automatic knife grinding is generally incorporated.

The leather is introduced into the closed machine between the feed roller (d) and the transport roller (a), and this controlled feed governs the traction exerted by the knife cylinder (b). The knife cylinder's peripheral velocity is greater than the leather in-feed speed, but rotates in the same direction.

With most machines feed roller (d)

closed position is set to shave down to the required substance. On modern machines, the setting can be electronically programmed to vary this. This is to take the natural skin substance differences in its various parts into account as shaving progresses (*operator activated mechanically/hydraulically on older machines*). The same device is also used to produce lateral inclination of the roller in relation to the knife cylinder (*used when shaving bovine sides*).

As a rule, feed rollers come in a concave shape, with the central section—about one third of the overall length—parallel. Left and right sections then taper off with a slight curvature. Rollers can be manufactured with various other profiles to suit specific applications. Some machines have a facility to mechanically curve the knife grinding slide ways to suit the required shaving profile.

The shaving knife

The spiral knife is fitted into the spiral-grooved cylinder. 14 or 12 right and left knives are frequently employed. The knife helix angle with reference to the vertical line is fairly standard at 29° to 30°. If the knife is fitted radially, that is at 90° to the cylinder diameter tangent, the front rake angle is also at 90° (*the cutting angle—see also Essay 12 Panel E12/2*).

In this configuration the action is more a scraping than a cutting one. Shaving machine makers often tend to machine the knife groove in the cylinder at a small forward angle (*in practice 6° to 10°*) which allows the knife to lean forward slightly in the direction of rotation. (*Panel E14/2*). When the knives are then ground in the machine, the cutting angle is an acute one depending upon the angle of the knife groove.

The action on the leather is therefore closer to a true cut, leaving a cleaner finish



Panel E14/3

Interactions and effects: The shaving operation

Differences in outcome due to the influence of temperature and moisture content of the piece are presented in *Essay 10*, where the role of elastic and plastic behaviour in machine operations is discussed. The shifts in properties described should be taken into account within the following table.

WET BLUE SHAVING

With reference to the primary objective of reducing the substance:

The leather is under pressure between feed roller and knife cylinder; so compression of the fibres occurs and strength is increased. The cut is at approximately 45° to the weave of the fibre bundles and some smoothing of grain takes place. Appearance of fat wrinkles are less likely than for example in splitting. Tightness of grain may be adversely affected. The moisture content of the leather is critical to achieve optimum effects and should generally not be less than 50%.

With reference to the secondary objectives, spreading and setting:

The shaving machine is not a setting machine but the system of knives used on the knife cylinder with an acute helix angle results in considerable lateral spreading of the skin. Setting in the direction of feed is less but friction between knives and skin combined with the surface heating of the skin also produces a setting action in this direction. The setting effect is related to the water

content of the skin - if too high the skin is elastic and the effect is not permanent.

COMMON PROBLEM EFFECTS:

Ribbing (chatter marks) which manifests itself by narrow closely spaced parallel lines (very shallow grooves) on the shaved flesh side. This can be caused by a variety of machine-related reasons. These include:

- Knife cylinder out of balance or ground not round
- A faulty or loose knife
- Machine structure or foundation vibration
- Faulty cylinder or roller bearings
- Knife grinder mechanical defects or incorrect grinding mode

Leather related causes include the leather being too wet or too dry. The cutting load on the knives becomes too high resulting in vibrations. Feeding at too fast a rate for the substance removal similarly creates knife overloading. This overload can be accompanied by considerable heat buildup, shifting the elastic/plastic balance towards plasticity and deformation. Some types of leather and tannage require more knives on

the cylinder than normally provided to avoid ribbing. Wide marks in the direction of feed travel occur in the middle of the skin and relate directly to the pattern of knife centre joints. Some leathers are more susceptible to this than others. (There are three accepted methods of making the left/right knife joint, changing the overlap pattern usually overcomes the problem.)

Modern robustly built machines are rarely the primary source of the problem. Defective re-blading or a single knife inadequately hardened are the most frequent mechanical problem sources.

DRY SHAVING: (AFTER STAKING AND FINAL DRYING)

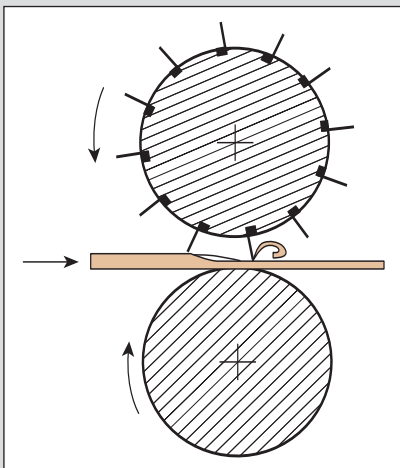
Key Objective:

Precision shaving to final substance.

Leather related causes include:

- Some loss of fibre structure strength
- Some loss of tensile strength connected with the shaving away of part of the corium of higher fat content (as a result of fatiquoring)
- Increase of stretch and suppleness

Panel E14/2: Climb milling type - configuration in the infeed shaving machine



as well as allowing slightly higher feed speeds. The result may also be observed on the shaving chip, which will not be ragged but nicely curled. More precise shaving

is claimed and knife service life is lengthened. (It is noted that milling cutters used for metal and wood cutting also frequently have a 10° front rake-cutting angle.)

Shaving knives, whatever their type of manufacture, are about 2.5mm thick at the base tapering down to 1.8mm at the cutting point. The clearance angle unavoidably is zero (see also essay 12 Panel E12/2) and for this reason, despite the very thin knife point, heat is generated by friction between the knife's outer face and the leather. If feed speeds are too high and/or the substance reduction setting is too great, the leather may be affected by excessive heat. Plasticity is increased, and ribbing on the leather surface may appear.

Setting and spreading in the shaving machine

The setting and spreading effect, which occurs during shaving, is related to the knife spiral angle as well as the cutting force acting upon the leather. The

relatively short spiral pitch resulting in the 29° - 30° helix angle produces a large lateral force and therefore significant spreading and setting action across the leather. The smaller force is in the longitudinal, downward direction, however, this is augmented considerably by the pull of the cutting force. (See also Essay 12 Panel E12/3).

In adopting the principle of climb milling, the leather must feed at a much slower speed than the peripheral speed of the tool, in this case that of the knife edge. Modern shaving machines achieve a knife point speed of about 19,500mm/second when the knife is new. However, this is reduced to about 16,000mm/second when the knife is worn to the point when it needs replacing. When feeding at the maximum speed as is generally used, the leather will travel past the knife cylinder at 500mm/second.

Additional Information:

"The Machines in the Tannery" – Walter Landmann
Shaving Machines, pages 116 - 129.